Deflections of Anisotropic Sandwich Beams With Variable Face Sheets And Core Thicknesses

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A sandwich construction consists of a low-density core material with high-strength face sheets bounded to the top and bottom surfaces. The construction has been widely used in the aerospace and marine industries due to its outstanding characteristics such as noise absorption, weight minimization, heat insulation, and better bending stiffness. In sandwich structures used in high-performance aircraft, the face sheets are often made of fiber-reinforced composite materials and the core is made of honeycomb. The stuctures may also have variable thickness so as to satisfy aerodynamic requirements. In the stress analysis, the constant-thickness face sheets are usually considered as membrane and the core is assumed to be inextensible but deformable in the thickness direction.

The static behavior of variable-thickness, isotropic and homogeneous sandwich beams was succesfully studied by employing a constant-thickness theory but allowing stiffnesses to vary in accordance with local thickness variations. It has been recently found in a refined theory that the analyses based on the constant-thickness theory locally can lead to significant errors in structural responses if the sandwich beam is thickness-tapered and the cores are deformable in transverse shear. The errors arise mainly from two factors: (a) the transverse shear components of the membrane forces in the face sheets alter the transverse shears carried by the core, and (b) the face-sheet membrane strains arise from transverse shear deformation of the core.

In practice the variable thickness may not only exist in core but also in face sheets. The thickness-variations may even be a type of step function. In this case the transverse shear stress in the face sheets and bending stress in the core should be taken into account in the refined theory mentioned. In the present study, energy principles are employed in deriving governing equations for general bending of anisotropic sandwich beams with variable thickness in both face sheets and cores. Solutions to these equations are based on a finite difference scheme. As an example in application, a simply supported thickness-tapered sandwich beam subject to a concentrated load at its center is considered. Let W' be the maximum deflection of the beam in which face sheets are considered as membrane, while W'' is that based on using the modified refined theory. It is found that W' is always larger than W'', however the magnitude of $(W'- W'')$ appears to be insensitive to the change of the taper of the beam.